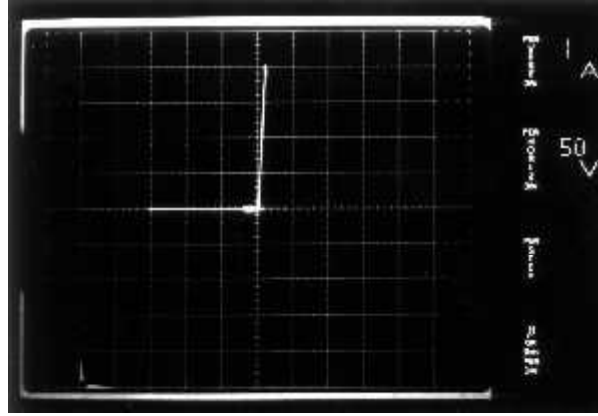


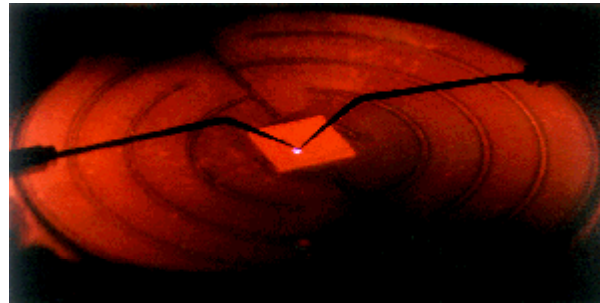
# Silicon Carbide High-Temperature Power Rectifiers Fabricated and Characterized

The High Temperature Integrated Electronics and Sensors (HTIES) team at the NASA Lewis Research Center is developing silicon carbide (SiC) for use in harsh conditions where silicon, the semiconductor used in nearly all of today's electronics, cannot function. Silicon carbide's demonstrated ability to function under extreme high-temperature, high-power, and/or high-radiation conditions will enable significant improvements to a far-ranging variety of applications and systems. These improvements range from improved high-voltage switching for energy savings in public electric power distribution and electric vehicles, to more powerful microwave electronics for radar and cellular communications, to sensors and controls for cleaner-burning, more fuel-efficient jet aircraft and automobile engines. In the case of jet engines, uncooled operation of 300 to 600 °C SiC power actuator electronics mounted in key high-temperature areas would greatly enhance system performance and reliability. Because silicon cannot function at these elevated temperatures, the semiconductor device circuit components must be made of SiC.

Lewis' HTIES group recently fabricated and characterized high-temperature SiC rectifier diodes whose record-breaking characteristics represent significant progress toward the realization of advanced high-temperature actuator control circuits. The first figure illustrates the 600 °C probe- testing of a Lewis SiC pn-junction rectifier diode sitting on top of a glowing red-hot heating element. The second figure shows the current-versus-voltage rectifying characteristics recorded at 600 °C. At this high temperature, the diodes were able to "turn-on" to conduct 4 A of current when forward biased, and yet block the flow of current ("turn-off") when reverse biases as high as 150 V were applied. This device represents a new record for semiconductor device operation, in that no previous semiconductor electronic device has ever simultaneously demonstrated 600 °C functionality, and 4-A turn-on and 150-V rectification. The high operating current was achieved despite severe device size limitations imposed by present-day SiC wafer defect densities. Further substantial increases in device performance can be expected when SiC wafer defect densities decrease as SiC wafer production technology matures.



*Current versus voltage-rectifying characteristics of a 4-A, 150-V SiC diode measured at 600 °C.*



*SiC rectifier diode being probe-tested at 600 °C. The circular heating element and the square, 5- by 5-mm SiC chip are both glowing red hot.*